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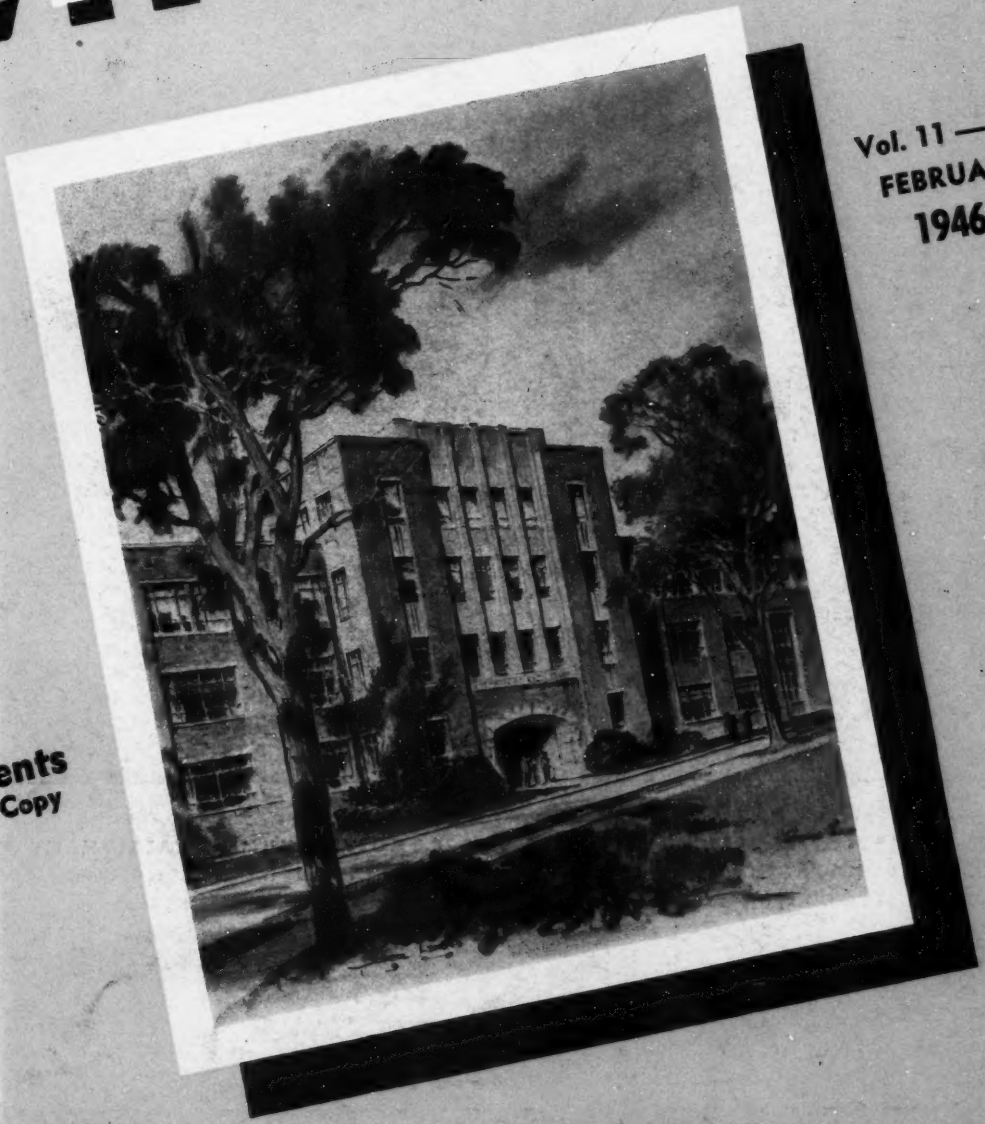

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—*Courtesy Westinghouse*

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This issue: February, 1946.

ELECTRIC SHIP PROPULSION

By DR. W. E. MESERVE, '29

Associate Professor of Electrical Engineering

THE foremost problem to be considered in connection with ship propulsion is that of producing rotary motion and of transmitting this rotary motion to the ship's propeller. At first thought, it seems a waste of energy to convert the mechanical output of an engine to electric energy, then to reconvert it to mechanical energy in order to drive the ship's propeller. This observation is particularly striking when it is remembered that the distance of transmission of the energy is relatively only a few feet. There are, however, many good reasons for the use of electric drives on ships, some of which will be discussed in this article.

Electric Drive Capabilities

The electric drive allows the high speed prime mover and the low speed propeller to each operate at its highest efficiency. Full power of the steam turbine or diesel engine can be applied to the propeller in the astern direction. This can, of course, also be accomplished with the recripocating engine and the reversible diesel but cannot with the geared steam turbine, in which case perhaps only about 80 per cent of full power astern may be obtained by using a separate, small, inefficient reversing turbine.

The electric drive (d.c.) reduces pulsating torque from diesel engine to propeller. Of course, the hydraulic coupling liquid drive and magnetic coupling will do this also. One or more of several prime movers may be used on a propeller, as needed for speed and power, and thus obtain high efficiency at reduced speeds.

Ship Power Requirements

Many ships require full power for only a part of the time. This is particularly true of many types of naval ships, where the ratio of full power to power at cruising speed is much greater than for most merchant ships. In the case of electric drives, part of the power plant can be shut down and the remaining part run at or near its rated power when the propeller demand is reduced. The power to drive a ship varies approximately as the cube of the speed and hence this is no small item. In an installation having two similar turbo-generator sets, approximately 80 per cent speed can be secured with only one set in operation. The efficiency of the part of the power plant used is considerably greater than when the reduced power is obtained from the full number of units. If this flexibility were to be attempted with turbine gears, extreme complexity in piping, with probably no true economy, would result on account of the operating conditions becoming unduly complicated.

Greater flexibility in arrangement, operation, repairs, replacement, piping layout, and auxiliary machinery layout are possible with electric drives. Electric drives permit the full propulsion power plant to be used to drive an auxiliary load. Some of the bulk carriers on the Great Lakes have self-unloading equipment and require approximately 1000 kw. for auxiliaries during unloading operations. The time that this power is needed is between 5 and 10 per cent of the operating time of the ship, so that if a separate auxiliary plant of the required

THE AUTHOR

Prof. Wilbur E. Meserve graduated from the University of Maine. After working in the Bell Telephone Laboratories and as an instructor at his alma mater, he came to Cornell as an instructor, and is now an associate professor of electrical engineering.

In addition to his work of teaching for which he is well known in Franklin Hall, Prof. Meserve has had a wealth of practical experience. During the summers he has spent considerable time working for General Electric Co., R. C. A. Victor Corp., and the American Brown-Boveri Co. He is a licensed professional engineer in New York State and a member of the AIEE. His academic honors include MEE and Ph.D. degrees from Cornell. Prof. Meserve is also a member of Tau Beta Pi, Sigma Xi, and Phi Kappa Phi honorary societies.

Dr. Meserve

capacity were installed, it would be idle the greater part of the time and thus not earn carrying charges. And finally, the electric drive is best as to smoothness and lack of noise and vibration.

Electric Drive Disadvantages

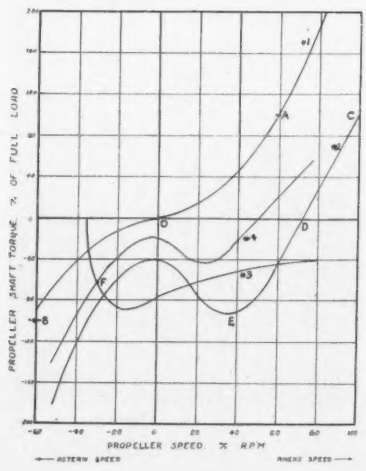
Some of the disadvantages of the electric drive should be pointed out along with the advantages. Among these are:

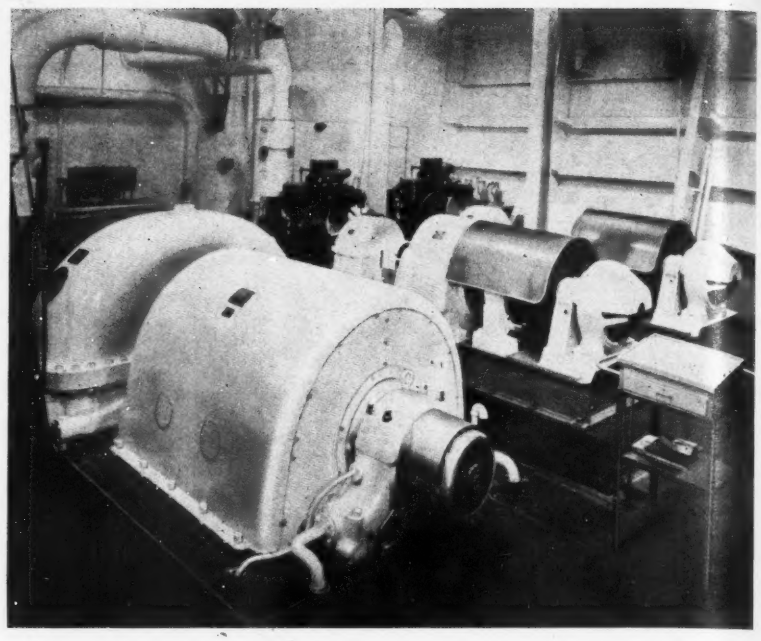
(1) somewhat greater first cost,
(2) a little greater weight,
(3) the overall fuel rate (shaft horsepower-hours per pound of fuel) may be a little more than that of the best mechanical geared drive, and
(4) the mystery about electric equipment, which is a psychological problem.

Electric Drive Classification

Electric drives may be broadly classified under three general headings, namely: Turbine Electric drives, Diesel Electric drives, including other types of internal combustion engines, and Electric Couplings used with internal combustion engines. Only the first two types of drive will be considered here. Each of these two types may be further subdivided into direct- and alternating-current types. The direct-current drive may be broadly considered as a variable ratio reversible gearing, and the alternating-current type as a fixed ratio reversible gearing, except where pole-changing has been used, resulting in the choice of two fixed gear ratios. In general, direct current has been applied to Diesel Electric drives only. A few direct current drives with steam turbines have been made, notably those where pilot house control was desired, such as on ferry boats. Most alternating current drives likewise have been applied to steam turbine equipped ships.

Fig. 1. The speed-torque curve of a typical propeller.





—Courtesy G.E.

Fig. 2. A typical engine-room scene on a ship using turbine-electric drive.

AC Motor Types

The form of alternating current motors used on alternating current applications fall into three general classifications:

(1) single and double cage induction motors,
(2) wound rotor induction motors with external resistance and
(3) synchronous-induction motors; motors that start as induction motors and run as synchronous motors.

U. S. battleships and airplane carriers have used various combinations of all three. In the early days of electric ship propulsion, it was thought best to use induction motors because of conditions imposed by maneuvering and, in naval applications where there are extremes in the ratio of cruising speed to full speed, this motor, which lends itself more readily to pole changing and hence to the operation of the turbine at practically the same speed for both conditions, seemed to be indicated.

In the merchant marine field the apparent advantage of pole-changing did not appear and hence the first synchronous-induction motors were applied to this class of service because of the lighter weight and increased efficiency during steady state operation. As a result of this experience and that of the U. S. Navy, practically all modern steam installations are of the synchronous-induction type. Consequently, a large part of the present discussion will be limited to systems having this type of motor.

But, before considering the detailed electrical and mechanical features of the system, it is desirable to consider some of the mechanical principles involved in the propelling of a ship through water. In most motor applications the main consideration is whether the motor is big enough to start and run the load, the size of the power plant backing up the motor being supposedly adequate. The characteristics of the load must be thoroughly studied and considered in the selec-

tion of the motor. In no other application of motors is the necessity for a complete and thorough understanding of the nature of the load more imperative than in ship propulsion. The propulsion equipment must provide for starting and reversing under some extremely adverse conditions. The motor design must be closely coordinated with the generator design.

Speed Torque Characteristics

Typical propeller speed-torque characteristics are shown in Figure 1. Curve No. 1 represents the ship at standstill in the water and it is noted that full torque ahead on the shaft corresponds to only about 60 per cent shaft speed ahead, as at A. Full torque astern corresponds to only about 63 per cent shaft speed astern, as at B.

If, however, full torque ahead is applied, after a time the ship's speed increases and finally, at full ship's speed, 100 per cent propeller speed will be obtained with 100 per cent torque, as at C on Curve No. 2. The torque on the propeller depends upon both the speed of the ship and upon the speed of the propeller. To represent all speeds between zero speed and full speed, a family of curves would have to be shown between Curves No. 1 and No. 2. If, with full speed on the ship the power is shut off, the shaft continues to turn at about 72 per cent speed ahead, as at D. Actually, the point would be on a curve a little to the left of No. 2 because the speed of the ship begins to decrease the minute the power is shut off. As the ship's speed becomes lower and lower, this free running propeller speed decreases until at standstill the propeller stops, as at O.

If, on the other hand, while the ship is running full speed ahead, the order comes for full speed astern, maximum engine output is called for. When astern torque is applied, it must go to nearly 95 per cent of full value with the propeller being turned by the ship to about 35 per cent ahead speed before the propeller's hold on the water is broken, as at E. Curve No. 3 shows the motor torque when running as an induction motor after the motor connections have been reversed, but before the propeller has changed direction. The length of ordinates of torque lying between Curves No. 3 and No. 4 shows the torque available for bringing the propeller to a standstill and, when carried over into the lower left-hand quadrant, the torque which is available for reversal. The point F where Curves No. 3 and No. 4 intersect in the third quadrant represents the point at which synchronization should take place by applying the motor field. This point represents the speed which may be attained by induction motor operation and at which synchronization should take place for minimum maneuvering time. Curve No. 4 shows the torque on the propeller for various speeds after the ship has slowed down to say, three-fourths speed.

The lower right hand quadrant of Figure 1 represents dynamic braking, with energy from the propeller returning into the motor and its control. The lower left hand quadrant represents a reversal of rotation but not of power which still is from motor to propeller.

For this condition then, of reversal from full speed ahead to full speed astern, known as "crash reversal," the motor requirements are that the motor shall deliver nearly 100 per cent starting torque at about 30 or 40 per cent speed in the direction opposite to the desired direction.

Syncro-Induction Motor Drive

The turbo-generator units are similar to those applied to land installations except for certain special considerations necessary because of their application to propulsion. The usual land turbine generator operates at constant speed and frequency, while in ship propulsion systems using synchronous-induction motors it is necessary to have a wide speed range for maneuvering. Thus a different type of governor and speed control for the turbine is necessary. It is also necessary to give careful consideration to the problem of critical speeds lying within the operating range. Figure 2 shows a typical engine room view on a turbine-electric drive ship.

The excitation system for the motor and generator is designed so that two or three times normal excitation is applied to the generator for short periods of time during induction motor operation of the propulsion motor. Much consideration must be given to the reduction of weight of the equipment, particularly as applied to Naval vessels. This problem concerns the operation as a synchronous motor under changing load conditions brought about by the sea. It is necessary to increase the excitation on the motor and generator in order to provide the margin necessary to prevent the motor from dropping out of step with large swings of torque. The systems are now provided with automatic excitation control which provides only the excitation required at the particular moment and, thus, a saving in weight in the machines is effected.

The synchronous-induction motor is the name given to a synchronous motor having a squirrel cage winding in the pole faces designed

(*Continued on page* 36)

Fig. 3. The main propulsion control board in a turbine-electric driven oil tanker.

—Courtesy G.E.

THE DEVELOPMENT AND PERFORMANCE OF THE TURBOSUPERCHARGER

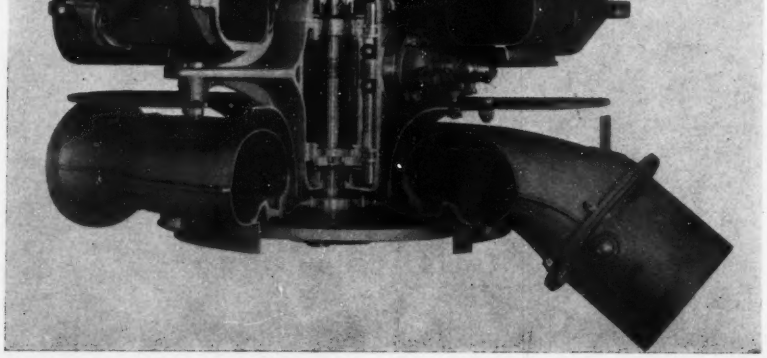
By MILTON S. GROSS, ME '46

DURING the adoption of the airplane as a combat weapon, and the gradual development of anti-aircraft guns accurate to 20,000 feet, airmen realized that in order to carry out the basic mission of United States air power, namely daylight heavy bombing, military aircraft would have to fly at very high altitudes. Some device had to be developed so that our bombers and fighter escorts could operate efficiently at levels above the effective range of ground defenses. The device, perfected by Dr. D. A. Moss after 25 years of constant research and produced in quantity by the General Electric Company, was the Turbosupercharger.* Equipped with one such supercharger per engine our B-17, B-24 bombers and P-47, P-38 fighters were able to fly 1,689,000 sorties and drop a total of 1,555,000 tons of bombs on the enemy in the European theater.

* The name Turbosupercharger is a trade name copyrighted by the General Electric Company. It is often referred to as the Turbo.

The need for supercharging is graphically shown in Figure 2. Note how atmospheric pressure drops off with altitude, being one-half sea level pressure at approximately 20,000 feet, and approximately one-third at 30,000 feet. Also note that the output of an unsupercharged engine, running at constant speed, drops off with altitude in almost the same ratios as does the air pressure. The slight variation is caused by the decrease in temperature with an increase in altitude. Generally speaking, with constant rpm., the output of an engine is proportional to the mass rate of air consumption, and therefore, power is proportional to air density (pressure and temperature). To get full power output from an aircraft engine at high altitudes, a supercharger must be used to compress low density air to sea level density air for presentation to the carburetor.

Fig. 1. Cutaway Turbosupercharger showing impeller-shaft-turbine assembly and lubrication pump. The compressor may also be made from an aluminum casting.



Types of Supercharging

Strictly speaking, superchargers are divided into two classes, internal and external. The internal supercharger is a radially vaned impeller geared to the propeller shaft and placed after the carburetor. Its purpose is to distribute the air fuel mixture uniformly to all cylinders. Depending upon the design, the internal supercharger may or may not also compress or supercharge the air fuel mixture. The external supercharger may be either gear driven from the engine shaft or exhaust driven. The internal supercharger is an integral part of the engine, while the external supercharger is an accessory. Figure 3 shows schematically a typical Turbosupercharger installation. The exhaust gases from the engine have two paths; one, through the nozzle box and out through the waste gate, the other, through the nozzle box and into the buckets of the turbine wheel. The amount of exhaust gases going to the turbine wheel, and hence, the amount of turbosupercharging, is controlled by the position of the waste gate. (Control of the waste gate will be discussed later). Connected to the turbine wheel by a shaft is the impeller of the centrifugal compressor. During compression the temperature of the air leaving the compressor casing rises above the auto-ignition temperature of the fuel, hence, an intercooler similar to a radiator on an automobile is used as the heat exchanger to reduce the temperature

of the air before it enters the carburetor.

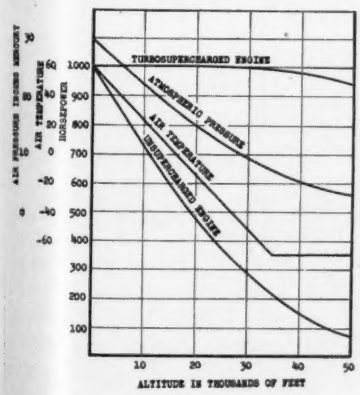
Besides the basic function of increasing intake manifold pressure, the Turbosupercharger may be used for ground boosting during the take-off when maximum power is needed. By boosting manifold pressures to 45″-50″ of Mercury, a 1250 hp. engine may be made to develop 1400 hp. This boost should not be maintained long at this high value, because of the severe stresses produced in the engine, and because of poor fuel economy. But ground boosting reduces the length of runway needed to get a heavily loaded plane off the ground. During cruising the supercharger may also be used to obtain the most economical fuel air mixtures.

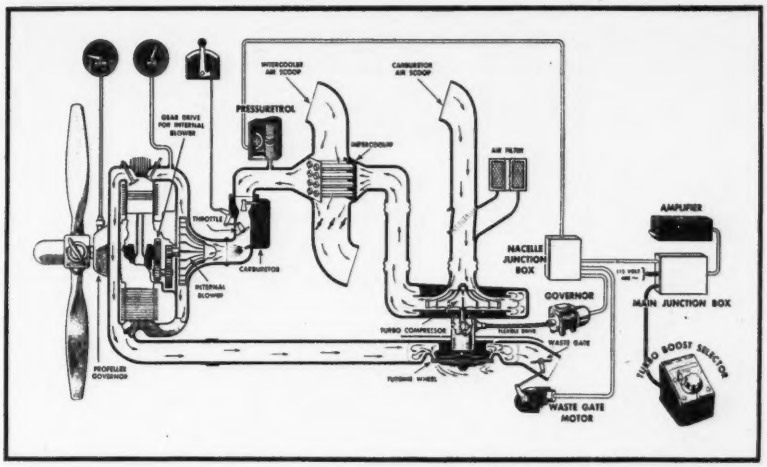
Another beneficial effect of supercharging is the maintenance of a favorable differential of pressure of intake to exhaust. If the intake pressure is higher, the residual gases in the clearance volume of the engine can be forced out during the valve overlap period. This improves the volumetric efficiency of the engine and lowers the initial temperature of compression, and reduces the tendency of the engine to backfire with lean fuel air mixtures.

History of the Turbosupercharger

The Turbosupercharger has had a long and interesting history. In 1917 Dr. William F. Durand in his capacity as chairman of the NACA, was requested by the Army to determine the feasibility of producing a successful supercharger driven by exhaust gases from an aircraft engine. Dr. Durand had been a professor in Sibley College in 1901 and

Fig. 2. Curve showing how the Turbosupercharger eliminates the effects of altitude on engine power output.





—Courtesy Minneapolis-Honeywell Regulator Co.

Fig. 3. Schematic diagram of electronic control system and associated mechanical parts of a Turbosupercharged engine. The pilot controls the entire system with the single knob on the turbo boost selector box at the lower right.

remembered the black clouds of smoke often emitted from the gas turbine research laboratory wherein a young man, now Dr. Sanford A. Moss, was working on his problem for a Ph.D. He then presented the problem of the exhaust driven supercharger to Dr. Moss who was a consulting engineer at the General Electric Company. Through the encouragement of the Army the General Electric Company began the development of what is now known as the Turbosupercharger. The first design was tested by the Army at McCook Field, Dayton, Ohio. It was then taken to Pikes Peak where a Liberty engine rated at 350 hp. was made to develop 356 hp. at an altitude of 14,109 feet. During the last 25 years, under the direction of Dr. Moss and the sponsorship of the Army Air Forces, the General Electric Company developed improved designs. At the beginning of World War II the General Electric Company was fully prepared for the mass production of the modern Turbosupercharger.

The most important advantage of turbosupercharging over gear driven external superchargers is the flexibility and accuracy of control. In the case of the gear driven supercharger, a mechanical clutch must be used to regulate the intake manifold pressures. The clutch mechanism, especially one of the variable speed type, is a heavy piece of equipment and is subject to the maintenance problems inherent in all gear systems. On the other hand, in the case of the Turbosupercharger the speed of the Turbo and hence the manifold pressure is controlled by merely regulating the amount of waste gases which is allowed to by-pass the turbine wheel. A simple butterfly waste gate accomplishes this. Furthermore, as the altitude increases, the power from the engine which is needed to drive the Turbosupercharger decreases while with the mechanical clutch-gear driven supercharger, the power absorbed for a certain rpm. is constant for all altitudes. At 30,000 feet, a gear-driven supercharger would absorb considerably more power from the engine shaft than the Turbosupercharger does by the slight increase in back pressure in the exhaust. As the altitude increases, the Turbosupercharger becomes a more efficient gas turbine because of the lower exhaust back pressure.

Waste Gate Control

The positioning of the waste gate is accomplished by an electronic regulator manufactured by the Minneapolis Honeywell Regulator Co. This regulator, utilizing a central boost selector operated by the pilot can maintain very accurately the manifold pressure which is set up for any engine of a multi-engined airplane. The sensitive element is a pressure bellows placed between the compressor casing of the Turbosupercharger and the carburetor. Be-

(Continued on page 32)

Engineering At Cornell

12. Soil Mechanics Laboratory

By PHILIP ERWIN SILBERBERG, CE '48

ONE of the more recent branches in the classification of engineering knowledge is called Soil Mechanics, where the solutions to problems dealing with soils encountered in engineering practice are treated most effectively. The science of Soil Mechanics, however, must be distinguished from the fields of geology and agriculture. The agriculturalists study the soil from the chemical and nutritional point of view with the idea of developing greater plant life; the geologists are primarily interested in the structure of the natural formations of the earth's crust. As the name implies, Soil Mechanics is a branch of mechanics and involves a study of the physical properties and uses of soil as an engineering material. Together with Soil Physics, it covers the classification of soils, the effects of stress distribution in soils, problems of equilibrium and deformation of soils, and the application of this knowledge to the design of foundations, roads, airports, tunnels, and earth dams, as well as other earth structures.

Soil Mechanics has been known in all its parts for a long time even though most of its knowledge has not been gathered together and correlated with physics or mechanics until recently. As early as the sixteenth century, the French were studying earth pressures and were using these studies in their fortification designs. One of the earliest published papers on earth pressure was written by Coulomb about 1773. Since then, similar isolated papers have been scattered through technical journals and transactions until about thirty years ago. Then a period of development in this field established Soil Mechanics all over the world as a separate branch of engineering knowledge.

Hydrometer readings and computations comprise most of the Mechanical analysis experiment. *—Deutch*

Practical Work

There are, however, other considerations beside theory in this field. The Soils Laboratory is becoming a more significant factor in Soil Mechanics, and may eventually become the dominating influence in its future development. Different methods of soil testing must be studied in the laboratory in order to determine the mechanical and physical properties of the soil for use in a practical way. It was to this end that the Soil Mechanics Laboratory was established in the Civil Engineering School at Cornell.

Lincoln Hall has been standing for quite a time, and the space now equipped as the Soil Lab has witnessed many bull sessions of Cornellians who used the room as the official Smoking Room of the C.E. School. In 1935 the old smoking room was taken over and completely rebuilt, although as a memory of the bygone days two athletic plaques won by Civil Engineering

School teams still hang over the analytical balances. Graduate work in Soils was the primary consideration for the first year, but elective undergraduate classes in Soil Mechanics were soon formed and began to hold sessions down in the laboratory. The course is now required for the Bachelor of Civil Engineering degree.

Temporary U.S.E.D. Lab

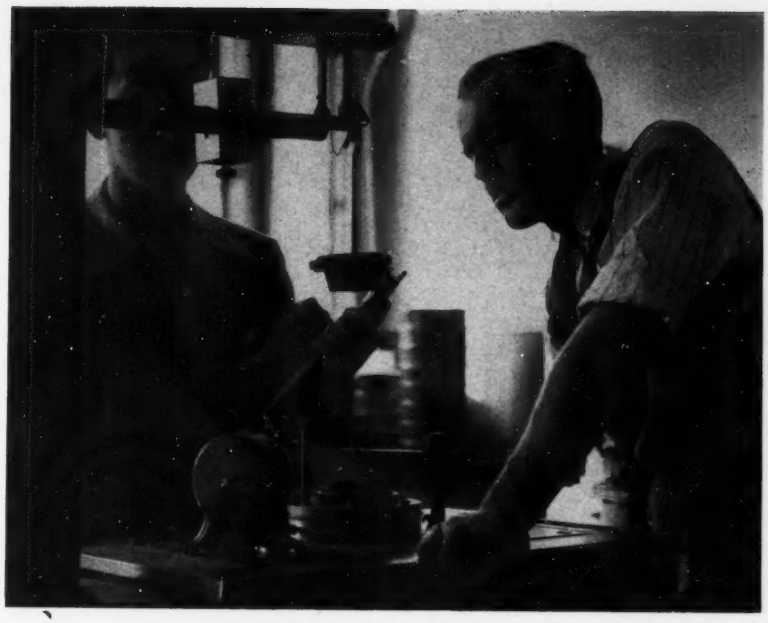
In 1936 the classroom north of the lab was remodelled to accommodate a temporary laboratory devoted to soils, and used by the United States Engineer Department until its new laboratory could be constructed on the Campus at the east end of Tower Road. In 1937 the U.S.E.D. lab moved out, taking all its equipment, but allowing for the further expansion of the Cornell laboratory.

Cornell is fortunate in having a very well-equipped laboratory for undergraduate teaching. There are few testing machines for soils missing from it, and plans to acquire even these few are now afoot. Much of the equipment was bought when the laboratory was started eleven years ago. This was one of the departments that really started from scratch.

Prof. Herbert T. Jenkins came to Cornell, after completing his graduate research work in Soil Mechanics, to continue his interest in the field by developing the laboratory and teaching the classes. There was no standard or suitable laboratory manual in Soil Mechanics available for the course, so it seemed reasonable for him to write one, which he did. The manual is designed primarily for the equipment in the Cornell lab, but it is also in use at many other universities.

—Deutch

Prof. Jenkins demonstrating the permeameter.



Testing soil with a Consolidation Machine. *—Deutch*

Results of Lab Work

The results of investigations conducted in a Soil Mechanics laboratory are applied in the construction of earth dams, in foundation and settlement investigations, in flood control work, airport runways, highways and highway embankments, channels and canals. Work of this nature is done at the United States Engineer Department laboratory which is visited each term by the individual laboratory sections. The engineers in charge of the testing are very cooperative, and effectively explain and demonstrate the equipment. This laboratory serves a large area of the northeastern United States, and discussions of the soil problems of such projects as the 1939-1940 New York World's Fair or the St. Lawrence Waterway Project never fail to interest the students.

Work At Cornell

In a less extensive way, the Soils Laboratory in Lincoln Hall is equipped for the same type of work. There is a consolidation testing machine, a shear machine, flow net apparatus, and equipment for the electrical analogy method. At present, the machinists are building the California Bearing Ratio equipment and a larger electrically controlled dehydrating oven. The Consolidation machine is used in a test to determine the rate and amount of settlement to be expected under a building or other load. It is ordinarily used on a saturated undisturbed sample from the job, and furnishes results which check consistently with the behavior of the structure in the field. The Shearing machine, used mostly for cohesive soils, is of the constant strain type and consists of several pairs of shearing boxes. This machine tests the tendency for a soil to fail in shear, a handy item to know when designing an earth dam or embankment. The flow net apparatus graphically shows the paths of seepage under and through earthen structures, such as earth dams. The electrical analogy of seepage also illustrates these flow nets, and some of the graduate work has been conducted along this line of investigation. The new California Bearing Ratio equipment is to be used for airport and embankment design and construction.

The machines and equipment noted above are used mainly for graduate research. The most recent

(Continued on page 28)

PROMINENT

Ray

Raymond Hunicke, EE

SINCE Raymond Lewis Hunicke entered Cornell as a sailor in the V-12 program away back in July 1943, he has earned himself a well respected position among his classmates, not only in the School of Electrical Engineering, but also in many extra-curricular activities.

Ray, a good student since he was knee high to a grasshopper, considers his excellent scholastic record just a matter of course. He is scheduled to receive a B.E.E. degree at the end of this term, has been on the Dean's list more than once, and has been a member of Eta Kappa Nu since June, 1945.

But according to Ray, his primary achievement while at Cornell has been the logging of over 100 hours flying time. Always intrigued by airplanes and amazed by their practicality, the sight of Mr. Peter's yellow Cubs flying lazily up and down the valley was too much for Ray to resist. Since March '44 he has flown many hundreds of miles over the surrounding territory and knows just about every airport within flying distance of Ithaca. Now, a co-owner of an Aeronca L3B, he is planning to take a trip around the country during his expected leave this March. Actually he has his fingers crossed for orders to the West Coast.

In connection with flying, Ray was very instrumental in forming the Cornell Pilot's Club—a rapidly growing organization of students interested in flying—and has been its Secretary-Treasurer since it was founded. He has also built a very compact, sensitive Aircraft Beacon Band receiver, which has helped more than once to get him back by the Navy's 1930 log-in time on Sundays.

Ray's other extra-curricular activities have made him a big asset to Cornell. As Assistant Swimming Manager in 1943-44 and as Manager during the 1949-45 and 45-46 seasons, he has been responsible for seeing that all their meets were properly conducted.

Undoubtedly the toughest job Ray has ever handled at Cornell was to direct the installation and operation of all lighting equipment used in the Octogon Club's production "Time Out" given on Spring Day, 1945. During the few weeks before that momentous night, Ray did very little sleeping and spent most of his time scouring Ithaca for arc lights, cable, and control equipment satisfactory for transforming

(*Continued on page 22*)

"Gil" Holmberg, CE

"GIL" HOLMBERG was born on December 21st, 1920, in Jersey City. Since that time, many things have happened, and a quarter century has run under the bridge.

He attended Wm. L. Dickinson High School in Jersey and was graduated from that school in January, 1939 (and it took him nine terms!) In the summer of 1939, the Holmberg family moved to a farm in the vicinity of New Paltz, New York. There Swede—as he is "affectionately" called by his "constituents"—became versed in the ways of the farmer. However, he didn't care for it as a lifetime occupation, so in November of 1939, he became involved in a shady deal—he went to work for Columbia Mills making window shades. But even that wasn't to his liking so in March of 1942, he went to work for Linde and Griffith on dock-building. He claims that he was just following in the footsteps of his father and grandfather who are also dockbuilders, but we contend that it was just the future C.E. in him coming out.

He held the job until November, 1942, at which time he enlisted in the Navy—the Construction Battalion, to be more exact. He received his boot training at Camp Allen, Norfolk, Va., and then was sent to Camp Endicott, R. I., for advanced training. From there, he went to Bermuda with the 49th C.B. for five months. While at Bermuda, he qualified for the Naval College Training Program and was transferred to Brother's College of Drew University at Madison, N. J., where he attended his first two terms of college.

On March 1st, 1944, he arrived at Cornell. While here, he has been elected treasurer of Tau Beta Pi Society, member of Chi Epsilon, C.E. Honor Committee, president of Rod and Bob Society, and a student member of A.S.C.E. He will be graduated February, and at the same time, will be graduated from the Navy by reason of enough points.

His favorite pastimes are drinking beer, shooting pool (and the bull), sleeping, and farming. His dislikes are few, namely Soil Mechanics, work, no beer, and E.E.

His plans for the future are a nice, long vacation—then—maybe—work. He hopes to get into heavy construction, dockwork, or foundations.

Gil

ENGINEERS

Henry Harper, EE

ONE of the better known engineers on the hill is Henry (Hank) Harper. His busy days at Cornell, including many extra-curricular activities, will end about February 26, when the Navy gains Hank as an ensign and Cornell loses a very good man.

Hank's first love is yachting. Since joining the Cornell Corinthian Yacht Club during his first term here, Hank has worked with great devotion and energy for the club. He was elected Commodore in March 1945 and organized a very successful regatta on Cayuga that spring. The boats the club owns were not suited for the competition of the regatta, so arrangements were made to borrow a fleet of Comets from the Ithaca Yacht Club for the affair.

It has always been a great desire of Hank's to see the Yacht Club here own a fleet of boats suitable for regatta competition, in addition to its three sailing dingies and the E-boat. Also a new, modern boat-house is needed. Pursuing these ideas Hank, as Commodore, has organized and inspired committees which have done a great deal toward buying a fleet of boats, leasing some lake-front property, designing the new boat-house (to be put up early this spring) and raising outside funds to back these expansion plans.

Hank

Sooner or later all of the more adventuresome and ambitious men on the hill seem to be bitten by the flying bug. Hank took instruction and first soloed early this past fall and is now well on his way toward getting a private license. A very great aid along these lines is Hank's recent investment in a plane, which he co-owns with his roommate. Both men are convinced that private flying beats train and car as a mode of transportation, so getting a plane of their own seemed the natural thing to do.

A testimony to his academic ability is Hank's membership in HKN, the E.E. honorary fraternity. Since Hank had his first term of college as a civilian at Harvard, the Navy did not require him to follow the Navy curricula. Thus Hank has been able to get a much broader education by taking electives in higher math and physics.

Incidentally, while at Harvard and earlier at Exeter, Hank was very active in the crew squad. He was elected Capt. of the Freshman Crew at Harvard during his one term stay there.

Early in 1945 Hank pledged Lambda Chi Alpha. At that time their house was being used by the Navy and a rented house on Stewart Ave. substituted. Now in their own newly-decorated house ΛΧΛ is once again in the full swing of prewar college days.

In a few weeks Hank will become a college-grad and an officer. Cornell will surely miss such an efficient and hard working man, but just as surely Cornell and the Yacht Club will long remember Hank's work here.

Francis Paul, ME

FRANCIS G. PAUL, better known to all as "Skip," is one of the first prewar Cornell engineers to return to school after having had his college course interrupted by the demands of Uncle Sam. He was a member of the Cornell advanced R.O.T.C. unit,

"Skip"

and was called to duty with them in May '43. After a period of six months with the Ordnance department, he became air-minded and transferred to the Air Corps where he was commissioned in the Air Corps Reserve as a navigator in Oct. '44. It wasn't long before he found himself in England flying with Jimmy Doolittle's Eighth Air Force where he saw his share of the action. At the end of the European struggle his entire bomb group was redeployed to the United States to prepare for the Jap War. But the Japanese played it smart when they heard that Skip was coming over and ended the war. So soon everyone called him Mr. Paul again.

"Skip" was born in Easton, Pennsylvania, a little over 24 years ago. He had always wanted to make the Navy his career. He's not sure why, but probably because his Dad was a Navy man in World War I. In order to fulfill his ambition he enrolled at the Admiral Farragut Naval Academy in New Jersey. His ambition was short lived, however, because he failed the rigid Annapolis eye examination. It was a blow at first, but he says it was one of the luckiest things that ever happened to him.

As "Skip" says—he wanted some sort of a well rounded technical education, so he had no trouble deciding that Cornell was the school for him. He admits to his friends that Carl Snavely's Big Red machine was what made the technical education at Cornell so well rounded. Skip always had been an outstanding athlete in High and Prep school.

(Continued on page 22)

NEWS OF THE COLLEGE

Phi Kappa Phi

On Wednesday, January 16, the following students in the College of Engineering were elected to membership in Phi Kappa Phi, honorary scholastic society:

School of Electrical Engineering: H. Richard Johnson, Thomas E. Talpey, and William J. Weigle.

School of Civil Engineering: John T. Collinson, Albert C. Cornish, Oscar M. Fuller, and Gilbert Holmberg.

School of Mechanical Engineering: Alfred E. Czerkas, Ralph W. Detra, Richard W. Jordan, Lee O. Mayer, Carl W. Mortensen, Frank E. Rom, and Varick D. Schwartz.

Atmos

On January 12, a party for faculty and student members of Atmos was held at Phi Delt. At the last business meeting, two new members were initiated—John Feitner and Richard Gavin. President of Atmos is Alex Brede; vice-president is Carl Ferris, secretary-treasurer is Charles Fox.

A.S.C.E.

During a recent meeting of the American Society of Civil Engineers, the President of Cayuga Rock Salt Mines gave a talk on the salt industry, entitled "Salt of the Earth." He described and compared the methods of salt mining home and abroad. As a follow-up of the lecture, the ASCE is hoping to make a tour of the rock salt mines in this area in the near future. President of ASCE is Oscar Fuller; vice-president, John Collins; secretary-treasurer, George Gates. Chairman of the Advisory Committee is Professor Schoder.

Chi Epsilon

Election, a double initiation, and a banquet highlighted Chi Epsilon's recent activities. The outcome of the elections was Oscar Fuller, president; John Collins, vice-president; Stuart Snyder, secretary-treasurer; and Gilbert Holmberg, editor to the *Transit*. A double initiation was held of new members and the old members who missed out on initiation last term. The new members are Thomas Berry, Richard Rundell, and Robert Loucks.

A.I.C.E.

At a recent meeting of the American Institute of Chemical Engineers in Olin Hall, John Drew was elected president; James Gillin, vice-president; Bert Ely, secretary-treasurer. A ChemE glee club is being organized, and plans are already underway for future meetings with guest speakers from prominent industries.

Bequest

A bequest of $5,000 was given to the University from the late Mrs. Gertrude Livingston Hamilton of Washington, D. C., in memory of her husband, James Hamilton '99, who died in 1943. A graduate of the U. S. Military Academy at West Point in 1890, Hamilton studied in Sibley College in 1895-96 as a special student and received the ME (EE) in 1901. He was for more than twenty years a patent lawyer in Washington, and practiced before the Supreme Court.

New Straight Manager

Professors Romeyn Y. Thatcher '08, Civil Engineering, and John S. Niederhauser, '38, Plant Pathology, Extension, have been appointed by President Edmund E. Day for two-year terms on the board of managers of Willard Straight Hall. They succeed Professors Charles I. Sayles '26, Hotel Administration, and Norman D. Daly, Fine Arts. General Alumni Secretary Emmet J. Murphy '22 is appointed to fill the unexpired term of alumnus member Alfred H. Grommon '33, who has gone to Stanford University.

Veteran's Housing Report

One hundred married veterans enrolled at Cornell University, their wives, and in some instances their children, will move into the temporary or emergency dormitory development the university is erecting near the East Ithaca railroad station, between Maple Avenue and Mitchell Street, at the beginning of the spring term early in March.

Erection of the 50 two-family houses has been proceeding rapidly during the last month, nearly half of the portable dwellings already assembled. At the present rate, all of the houses should be erected within several weeks, weather permitting.

However, the work of completing the interiors, laying of new asphalt strip roof shingles, matched boarding and special sheeting from the bottom of the structures to the ground, connecting water, soil, and electric lines, and similar work will keep the workmen pushed to complete the project by March 1.

Brought to Ithaca from Massena, where they served as dwellings for war workers at the Aluminum Company of America plant during the last several years, the houses will provide relatively comfortable accommodations since the ceilings, walls and floors are heavily insulated, permitting adequate heating in the winter, and protection from undue heat in the summer. Occupants were comfortable during outside temperatures of as low as 30 degrees below zero in Massena last winter.

Although not large (24 feet by 28 feet), the houses are compact. Each living unit or apartment contains a combined living room and dining room which measures 17½ feet by 14 feet, including kitchen alcove. The bedroom is 12 feet by 9 feet; the bathroom six feet by 5½ feet.

The interior walls are plywood with natural grain finish except in the bathroom where white paint has been applied. Each apartment has its space oil-burning heater, and a separate oil burner to furnish hot water.

The kitchens are equipped with a combination sink, electric hot plates and roaster, metal cabinet, and ice

(*Continued on page 26*)

ALUMNI NEWS

COLONEL KENNETH D. NICHOLS, MC. E. '32, engineer in charge of the Manhattan District, made the first announcement that atomic bombs are still being manufactured in this country while speaking before a meeting of the Cornell Club of St. Louis.

R. Harris Cobb, president of the Club, was cheered to find that, for the first time in history, a Cornell Club dinner made the front page of two St. Louis newspapers and the second page, with photograph, of a third.

Colonel Nichols discussed problems concerned with the manufacture of the bombs. He was introduced by Dr. Arthur H. Compton, former director of bomb research at the University of Chicago's "metallurgical Laboratory" and recently appointed chancellor of Washington University in St. Louis. Other guests of honor were Colonel Nichols' aide, Lieutenant Colonel Arthur Peterson, M.C.E. '36, and Charles Thomas, vice-president in charge of research for the Monsanto Chemical Co., of which Edgar M. Queeny, another Cornell graduate, is president. Thomas gave a vivid eye-witness account of the first experimental blast in New Mexico.

HARRY P. REIBER, M.E. '08, engineer with A. O. Smith Corp., Milwaukee, Wis., returned this fall from Germany where he and a colleague spent three months studying Nazi production methods for the U. S. Army Air Corps.

Reiber believes that Germany's failure to maintain a consistent and aggressive research program was one of the reasons why she lost the war. In fields where the Germans continued work, for example, in jet propulsion, thermodynamics and aerodynamics, they kept far ahead of the United States. The weak spot was the two-year period in which they rested on their laurels in some fields, such as radar, while the Allies forged ahead.

While in Germany, he succeeded in locating for British and United States authorities Dr. K. N. Kramer, German expert on jet propulsion and propellers.

LELAND H. HILL, E.E. '22, has resigned as vice-president in charge of industrial relations for the Allis-Chalmers Mfg. Co. to become publisher of Electrical World and Electrical Contracting, McGraw-Hill Publishing Co.

He is an industry member of the National War Labor Board and was an alternate delegate representing industry at the President's National Labor-Management Conference.

Harry W. Kellogg, who was one of the two students in electrical engineering when the course was started in 1882, is still actively engaged in precision work at the Greenfield Tap & Die Corp. He has a picture, taken by Professor Newbury, Andrew D. White's son-in-law, of a generator and arc lamp which he developed. When the water was low in the University reservoir, Professor William A. Anthony of the Physics Department, would ask him not to use his light.

Kellogg also has some of the first "draw" from a furnace for melting iron that a corporation gave the University. In 1880 he made a 0″-2″ micrometer recently found accurate by Government standards. In the early 1900's he was in charge of the gauge department of his present firm's predecessor, designing the first snap gauge and limit gauge from which modern gauges have been developed.

WILBUR R. LEPAGE, E.E. '33, Ph.D. '41, helped to perfect in the Johns Hopkins University radiation laboratory at Baltimore, Md., the radio proximity fuze, second only to the atomic bomb as a U. S. secret weapon and widely used in all theaters of war by both the Army and Navy.

LePage received the Ph.D. as a John McMullen Graduate Scholar in Engineering. He rowed on Freshman and Junior Varsity crews; is a member of Quill and Dagger, Tau Beta Pi, and Phi Kappa Phi.

A "top secret" war research project, the fuze is a tiny five-tube combination radio transmitter and receiving unit built into the nose of high explosive shells. In flight, the fuze transmits radio waves which, when reflected from a target, are caught by the receiving unit to detonate the shell.

GERALD F. HEALY, C.E. '15, is president of Gerholz Healy Co., now building 250 homes in Flint, Mich. The company built 500 homes in the last four years.

ARCH E. HOUSTLE, M.E. '34, has left the Glenn L. Martin Co., Baltimore, Md., and has bought half interest in a laundry and dry cleaning company. During the war he was for three and a half years at the Martin plant in Omaha, Neb., which made B-26 and B-29 bombers for the AAF, as chief tool and production engineer.

CHARLES P. STOLBERG, C.E. '31, has been appointed chief mechanical engineer of H. K. Gerguson Co., Cleveland, Ohio. He was formerly project engineer on industrial building construction.

JOHN F. MCMANUS, C.E. '36, has accepted a position with Sheffield Farms, New York City.

This past summer he was acting assistant professor in Civil Engineering for Cornell's summer term, and for three years was in charge of the University's engineering courses in the Engineering, Science, and Management War Training program in Buffalo.

AFTER the dinner meeting of the AIEE on January 11, Mr. Frank Godsey, Chief of the New Products Division of Westinghouse, presented an illustrated lecture on the performance of gas turbines and prop-jet engines installed in aircraft.

Mr. Godsey, holder of a BS in

(*Continued on page* 24)

Recent Developments In Engineering

Techni-Briefs

Lilliputian Power Plant

A MINIATURE educational power plant, designed to permit convenient study of all operations of any type of industrial or city standard power plant, has been developed for use in laboratories of engineering colleges.

The complete, co-ordinated "packaged" unit occupies a floor space of only 10 by 15 feet and stands approximately six feet high in contrast to a standard power plant that would need a two-story, half-block-long building to house it. Total weight of the unit is approximately 20,000 pounds as contrasted to some 1,000,000 pounds a city power plant would weigh.

Despite this diminutive size, the "Lilliputian" power plant embraces all equipment component to its commercial "big brothers" including two 20-kilowatt steam turbine "load," complete four panel switchgear equipment, a condenser, miscellaneous piping, and a foundation.

During operation, total power of 40 kilowatts generated by two steam turbine generators is dissipated by an electric motor "load," driven by a water brake. The unit requires only a supply of steam ranging from 125 to 250 pounds and source of circulating water for condensing purposes.

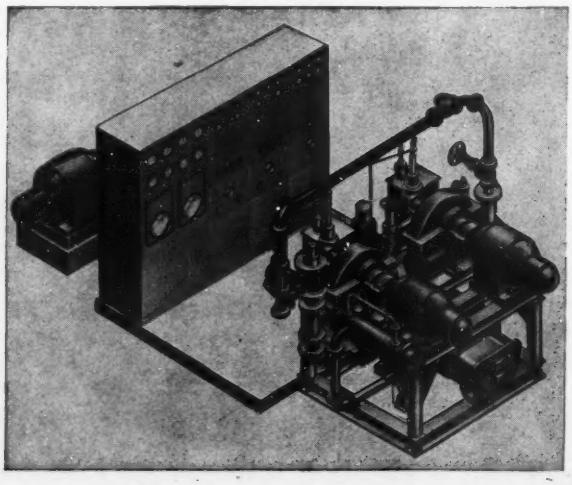
New education methods, emphasizing the technique of demonstration, and a current trend toward more practical education are responsible for development of the miniature unit.

Use of a standard-size power plant is not feasible for individual colleges during peace-time, but this new technique of demonstration can be made adaptable through use of a miniature power plant.

A miniature unit, in fact, holds an advantage over a standard power plant. Usual study systems employed by colleges call for one or two field trips per semester, during which classes visit the nearest power plant. Because of the few number of trips and the tremendous size of the plant, each student receives a specific study assignment, sees only a part of power plant operation, and thus misses the over-all perspective.

A miniature power plant, however, can be set up so that each member of the class can watch the entire operation at once, and as many class periods as are deemed necessary can be conducted on a daily basis at the location of the unit.

Model Power Plant



Fish Fence

THE fish in the state hatcheries at Pennsylvania's famed Pymatuning Lake reservation, near Linesville, are well behaved these days, as an instrument as modern as the radar used in military operations is helping to keep the finny tribe in line.

The new device, an electronic fish fence, keeps the fish in waters where they are protected, thereby saving millions of them for later "planting" in the streams and lakes of the state.

The screen, or "fence," consists of one or more rows of metal rods or strips that serve as electrodes through which electrical impulses are sent to set up an electric field in the water.

The special electronic generator through which the electric impulses are controlled and which has made the operation of the screen possible was built by engineers of the Westinghouse Electric Corporation.

This electric impulse creates an electrical force that gives the fish an effective but harmless shock and sends them scurrying back to a safe area. The electric impulses are produced at a relatively rapid rate from the electronic generator, resulting in a special wave form of electric current that turns back both large and small fish simultaneously, an impossible feat with ordinary current.

At Pymatuning, the electric fence prevents the fish from migrating to open water where they would be caught by fishermen or eaten by larger fish.

The "fence" has other extremely practical applications in preventing fish from being destroyed in the water intakes of irrigation projects, hydroelectric plants, and industrial works. A number of the rod-type fences have been installed in California with marked success.

Explosive Rivet

AN explosive rivet especially adapted to meet the needs of peacetime mass production methods was announced recently by E. I. du Pont de Nemours & Company. This improved rivet is the latest development in the explosive type of "blind" fasteners used extensively by the aircraft industry during World War 2.

(*Continued on page* 30)

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

Mr. Leinroth

President's Message

OUR country, united in war but seemingly at swords-point now that peace is here, is in a reconversion period—reconverting from a war time to a peace time economy. This in itself is a critical change. But the year 1946 is going to mark much more than just that; indeed it may well go down as one of the critical years in the history of civilization. It is already being compared in worldly significance to the year 410 A.D. which marked the fall of Rome. We are told we are at the end of an era and entering a new one and that the decisions we make now may well determine in no small measure the course civilization will take in the next decades and centuries. It would be well if all engineers ponder over this.

We are living in a changed and fast changing world. Our scientific and technological achievements, leading finally to the atomic bomb, have posed for us new problems to solve—national and international, social, economic and ethical. Our scientific progress has far outstripped our ethical, social and economic progress. All of this is of great import to engineers.

The engineer, to be sure, has been a dominant figure in the great scientific and material progress of the past. This progress has social, economic and ethical implications and ramifications of which the engineer of the future must take more cognizance if he is to take his proper place in the world of tomorrow. Our entire economic conception has been changed—of the state, of the natien and of the world.

All of this sums up to one thought—the engineer of tomorrow must be broader in his viewpoint, must concern himself and must be better educated in matters other than technical than he is today. Sooner or later most engineering graduates are called upon to act in an administrative capacity in industry or public service. There they are called upon to face these broader problems representative of the social, economic and ethical aspects of the new age. More and more the engineer will be called upon to deal in finance, with industrial and labor relations and with humanistic matters. This is, of course, as it should be and the greater and broader responsibilities which he will be called upon to carry should not in any case be looked upon as a burden but rather as an opportunity for greater service. On his part it will call for breath of vision and understanding. His education and training must be wider in its scope if he is to carry his new responsibilities successfully.

It goes without saying that the engineer of tomorrow must have had a thorough technical training with emphasis on the basis fundamentals of engineering. He should be able to make effective use of the English language both orally and through the written word. He should have a good grounding in the general principles of economics, finance, management and labor relations. He should have a sympathetic understanding of the development of our modern civilization, of our government and of the world we live in with special reference to their social and ethical implications.

There is, of course, nothing new in this thesis. It has been preached for years and its importance has been more and more appreciated. But it bears stressing now for in the new era, of which this is the beginning, it takes on an added importance. It is not enough to achieve efficiency; it must be guided and devoted to humanitarian purposes; it must work for the good of mankind, not for his destruction. Our technics must be brought under a benevolent social control and in this lies the future path and opportunity for the engineer. Whether we are on the threshhold of another golden age or a nightmare is going to depend very largely on his leadership. Never before have we had such a need for leadership; never before has the opportunity for being such a force for good been given to the engineer.

In such a time as this when the broadening of engineering education takes on a new significance it is particularly heartening to see Cornell once more take the lead by adopting the five year engineering program which will provide for courses which will tend to broaden the outlook of the young engineering graduate and help him to better grapple with the problems ahead. This lead is bound to be followed by other engineering schools; as a matter of fact the trend in that direction has already started. We may all take pride in Cornell's pioneering part in it.

J. PAUL LEINROTH

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Ray Hunicke

(*Continued from page* 14)

Bailey Hall into Ithaca's version of a Broadway theater.

For the past two terms Ray has been the very efficient and capable Treasurer of the Senior Week Committee. It is Ray's job to handle all the finances of the various Smokers, Parties, and the Senior Ball held during Senior Week.

In addition to being a man capable of handling the most responsible jobs, Ray has a much more carefree and jovial side to him. He is considered one of the top party boys on the Hill, and as such, he holds the honored position of President of Pi Beta Tau, an organization formed expressly for the purpose of holding social functions. Much of Pi Bate's reputation for holding the best parties on the Hill stems from Ray's spontaneous wit and unrestrained joviality.

Ray's future plans are many and varied. If at all possible, he wants to get connected with aviation, either as a pilot or as a salesman for one of the light plane manufacturers. He would like to transfer to the Naval Air Corps to get more flight instruction if it should be possible without signing up for an extended hitch. Other plans concern a certain redhead out in Kentucky, and the possibility of spending a year at the Harvard Business School. He has even entertained the idea of working in the Standard Oil Company's plant in Sumatra.

When Ray graduates this February, Cornell will lose one of its most sincere, hardworking, and enterprising students. Cornell is indeed indebted to Ray, but it says, "Good bye" to him with the knowledge that he will make good at whatever he may try his hand, whether it be oil refining or selling his neighbor a "flying fliver."

"Skip" Paul

(*Continued from page* 15)

He played football and baseball, gaining All State honors in football at Admiral Farragut Academy in '40. He played freshman football for "Mose" Quinn in '40 when the Big Red Varsity was the oustanding team in the country. He admits that he would have given anything to have played with that outfit. "Skip" played varsity football in '41 and '42 winning his first major "C" his sophomore year. His football career was brought to an abrupt end in the Army game of 42 because of a serious knee injury. When asked if he would play again—he only smiled and said, "It's a young man's game now; besides I'll be graduating in June 1946 with a B.M.E. degree."

"Skip" is one of the few BMOHs left on the Hill, being a member of practically every society you can belong to. He is listed on the membership rolls of Scabbard & Blade; Quill & Dagger; Aleph Samach; Atmos; A.S.M.E.; Kappa Beta Phi; and the Cayuga Blasters. He is also a member of the Sigma Nu Fraternity.

You can call "Skip" Daddy now since he is the proud possessor of a husky six months old son named "Stephen." He is anxious, as most veterans are, to finish his undergraduate work and start in the business world. His plans aren't definite yet, but he hopes to be able to get into some phase of Industrial or Production Engineering.

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CHEMICALS INDISPENSABLE DOW TO INDUSTRY AND AGRICULTURE

Alumni News

(*Continued from page* 17)

EE degree from Rice Institute and an advanced degree from Yale University, has been with Westinghouse for the past five years. Prior to 1940, he was associated with The Safety Car Heating and Lighting Company and Sprague Specialities.

W. Dean Wallace, M.E. '40, has been promoted to lieutenant (jg), USNR, and was at Nago Wan, Okinawa, early in November.

Ensign William D. Knauss, USNR, B.S. in M.E. '45, is engineering officer on a patrol craft operating out of Dutch Harbor, in the Aleutians.

Herbert J. Reich '24, formerly professor of electrical engineering at the University of Illinois, now at Yale, was editorial director at Radio Research Lab in '44 and '45. This laboratory is a division of OSRD located at Harvard University and staffed by scientists recruited from universities all over the U.S. Its main function was the development of radar countermeasures.

Lieutenant William A. Miller, USNR, M.E. '40, has returned home on terminal leave after more than four years of active service. He went to the Pacific in 1943 as a dive bomber pilot on the aircraft carrier U.S.S. Yorktown. Returning to this country in 1944 for a short leave, he was assigned to Bombing-Fighting Squadron 87 aboard the carrier U.S.S. Ticonderoga as pilot of a Gruman Hellcat.

In addition to seven stars on his Pacific campaign ribbon, he wears the Air Medal with a gold star for meritorious achievement.

Colonel Alfred C. Day, M.E. '14, has returned to the United States and is now on terminal leave. Overseas since July, 1943, he assisted in the training of Normandy invasion troops at the U. S. Assault Training Center in Devon, England. He served as deputy chief chemical officer, ETO, in London and Paris from March, 1944, until his departure for the United States.

Dionisio Saurez, Jr., C.E. '24, is acting as director of Central Highway, Commision de Fomento Nacional, Havana, Cuba. He has been with the commission for two years, previously serving as chief engineer. In 1942 he was field engineer, chief of surveys, with the Cayuga Construction Corp., building a large airport in Cuba.

"HOW TO CHOOSE A SLIDE RULE" — *By Don Herold*

This is a twenty-two page booklet which you can secure Free at The Triangle Book Co-op. We are prepared to furnish books and supplies used in your courses at Cornell.

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6" Polyphase	$3.75 and $4.25
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Made of metal and large enough to hold triangles, scale stick, ink, and drawing instruments. Of pre-war design for $2.00.

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Naturally we carry at all times Triangles, T-squares, Cross-section paper, drawing ink, Pencils, Erasers, etc.

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"TRAMP IRON" — IT'S BAD STUFF

A Giant "Pennsylvania" Bradford Crusher intercepted and automatically removed this gruesome "Tramp Iron" while crushing R.O.M. Stoker Coal for a 525000 KVA Mid-west Power Station. Stokers and the Coal Conveyor System were saved from unthinkable shutdowns and incredible grief.

Pennsylvania Crusher Co. builds equipment for Primary and Secondary reductions and for the beneficiation of Coals, Ores, Limestones, Gypsums, Refractories, Chemicals, including a wide range of Industrial Minerals.

Main Office **LIBERTY TRUST BLDG., PHILADELPHIA, PA.**

College News

(*Continued from page* 16)

refrigerator. The apartments are also supplied with 6 straight chairs, dresser with mirror, double bed with springs, mattress and pillows, a day-bed, and table. Floors are covered with linoleum. Each apartment has two closets.

Bathrooms contain a combination tub and shower, standard wash basin, toilet, and medicine cabinet. Each apartment has one entrance which has a small porch or stoop.

Hugh E. Weatherlow, superintendent of buildings and grounds at Cornell, is in charge of the erection of the houses and related construction and grading work. James E. Matthews, assistant treasurer of the university, will supervise the operation of the development, and is already being referred to as the "mayor of Vetsburg."

A new street, 24 feet wide and 1500 feet long, will be constructed between Maple and Mitchell streets, running directly through the housing development, and will be named "Veterans Place." Four-foot sidewalks will border the street. Houses will be approximately 18 feet from the street, and at least 25 feet apart.

Water mains and laterals into the houses have already been laid, water to be supplied from the city's tank-reservoir in East Ithaca. Approximately 1900 feet of mains were required, and 600 feet of laterals—all of transite pipe. Sewer lines have also been laid to connect to the city's disposal system, and this installation required the use of 2338 feet of main lines and 600 feet of laterals.

Electricity will be furnished by New York State Electric and Gas Corporation, each apartment to have a separate meter. Street lights will be hung throughout the area. Charges by the city for water and sewage disposal will be paid by the university and included in the rent. No decision has been reached on rentals as yet, but the university intends to make the charge as low as possible.

Some landscaping will be done upon the arrival of warm weather, to include grass and possibly some shrubbery.

Actual erection of the houses has been placed in the hands of Putnam and Hawley Construction Co., Inc., of Colton, N. Y., who dismantled the houses in Massena and arranged for the shipment here via 38 boxcars and 10 motor vans. Furnishings will arrive within a few weeks. A total of 43 men are working on the job, 27 of whom were hired in Ithaca.

In anticipation of the arrival of more than 200 new residents in the area, an adjacent grocery store is planning some expansion, and to convert the store to self-service style.

In the next issue:

Our New Aeronautical Lab In Buffalo

by

Dr. C. C. Furnas, Director

WANTED

By Major Oil Company

Petroleum, Mechanical, Electrical, and **Chemical Engineers** with little or no experience. Minimum requirements, B.S. degree. Higher degrees desirable. Also, **Geologists, Stratigraphers, Paleontologists,** and **Geophysicists** with little or no experience. Minimum requirements, B.S. or B.A. degree with major in geology. Higher degrees preferable. Write Box 12, Lincoln Hall, Ithaca, N. Y.

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Est. 1870

A Regents School where aim is to prepare students for University work.

Special attention to students with unusual programs or to whom English is a foreign language.

University Tutoring

Tutoring in university courses that is effective because directed to individual needs.

Special attention given to the needs of veterans

DIAL 2014 ITHACA, NEW YORK

C. M. DOYLE '02, *Headmaster*

IT'S LIFE FOR BEVERAGES *and death to fire*

To a raging fire, Carbon Dioxide gas means sudden, certain death. Yet this same gas puts "life" in beverages—tongue-tingling bubbles that make soft drinks sparkle. For fighting men it's a life saver in other ways . . . inflating collapsible life-rafts and "Mae West" life-jackets; creating synthetic "smoke screens"; shielding packaged foods against spoilage; processing blood plasma and penicillin.

In its varied applications, Pureco Carbon Dioxide reflects the far-ranging usefulness of all Air Reduction products . . . from oxygen tents to welding torches.

For interesting and educational reading, write Dept. CP for your free copy of the 56-page illustrated book "A Quarter Century of Progress". It describes and illustrates the operations and products of Air Reduction and its subsidiaries.

The operating subsidiaries of Air Reduction Company, Inc., are:

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We can offer the Services of our Experienced Construction Personnel to help you Design, Prepare both budget and bid Estimates, and Build in this Post War Period

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Weekdays
LUNCHEONS 11:30-2:00
DINNERS 5:30 or 7:10

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Sundays
DINNER 12:45 or 2:10

* * *

Closed
SUNDAY NIGHT — MONDAY
No Phone Calls While Closed, Please

Soil Mechanics

(*Continued from page* 13)

research work done in the Cornell Soils lab was in progress from 1935 to 1940, when investigations of design and tests for earth dams, stresses in dams, and percolation were completed. This work was terminated by the accelerated war program, but with the large influx of students at the present time, it is expected that graduate research will be resumed in the very near future.

Undergraduate Work

In the undergraduate laboratory work, the first sessions of the term are devoted to finding the moisture content, the specific gravity, and the void-ratio of disturbed samples of soil. These conditions serve to indicate the type and state of the soil tested. Following that, a series of experiments known as the Atterberg Tests are run, to determine the Atterberg Limits. These limits are necessary in a rapid method for the preliminary classification of soils devised by the Public Roads Administration. The tests are made on a soil as it changes from a liquid state to the solid state with a decrease in water content and are performed with simple equipment. A percolation test is run, using apparatus called a permeameter in order to determine the coefficient of permeability. This coefficient is a measure of the amount of water which can percolate through the soil under given conditions.

Reading one of the balances.

After these preliminary tests have been completed, a mechanical analysis of the soil is made, using the Sieve Test and the Hydrometer Test. This mechanical analysis is a means of finding the percentage of each size-range of soil particles in the sample, and determining the proportions of sand, silt, and clay present. The rest of the term is devoted to more advanced tests such as the Consolidation Test, the Shear Tests, and the Proctor Test for ascertaining the optimum moisture content for maximum compaction. As mentioned earlier, one of the laboratory periods is devoted to a visit to the U.S.E.D. laboratory out on the Ag Campus.

The Soil Mechanics Laboratory gives the student a chance to apply the theoretical material directly to practical work in the field. The combined lecture and laboratory course also provides a background for other subjects such as Foundations, Highways, Airports, and Design of Hydraulic Structures.

"No unhitching... no feeding!"

A full-color reproduction of this painting suitable for framing will be sent upon request

So claimed Charles Duryea for his horseless carriage. He had built it in a barn in Springfield, Massachusetts, and it was the first of its kind in the country.

It was the year 1892, when gasoline was to be bought by day at the hardware store and by night at the corner drug store. The new contraption had "two speeds forward and one reverse, and was operated by an up and down movement of the steering handle."

We have come a long distance since Charles Duryea's day. One measure of that distance is the universal use in motor vehicles of ball and roller bearings such as SKF produces. For SKF has contributed much to the automotive industry, and the presence of SKF Bearings is a warranty of quiet performance and low maintenance cost.

Since SKF makes many types of anti-friction bearings, an SKF engineer can give you expert help in selecting

THE RIGHT BEARING FOR THE RIGHT PLACE

SKF INDUSTRIES, INC., PHILA., PA.

SKF
BALL AND ROLLER BEARINGS

7000-A

Technibriefs

(*Continued from page* 18)

Retaining basic features of previous types, the improved design eliminates the necessity for close tolerance drilling and provides rivets which will accommodate a wide range of metal thicknesses. These features are in direct contrast to those of the explosive rivets supplied to aircraft manufacturers where precision tolerances and a wide variety of lengths were required.

After explosive rivets are in place one person applies the tip of an electrically heated iron to the rivet heads. Heat fires the explosive charge within approximately two seconds. The shank of the rivet is expanded to fill the hole completely and a barrel-shaped head is formed on the "blind" end to lock the rivet securely in place. The strength of these rivets is only slightly less than that of conventional solid rivets.

Explosive rivets will be useful in the automotive industry for construction and maintenance of chassis, bodies, accessories and parts. In refrigeration cabinet construction for farm and home freezers, locker plants, commercial refrigerators—explosive rivets will be helpful at many points.

They are well adapted for the construction of prefabricated housing, for attaching paneling and similar applications. They will be suited to the construction and sealing of air-conditioning ducts and in the heating and ventilating field for the fabrication of furnaces, stokers, and housings.

Competition

THE CORNELL ENGINEER
announces its
Spring Competition
For positions on both
Editorial and Business Boards.

Experience not essential.

All engineers invited to an orientation meeting in
Room 15
West Sibley
21 March, 1946
At 4:30 P. M.

For Legless Drivers

A special device to accommodate legless drivers, invented by Harry A. T. Krueger of Milwaukee, Wisconsin, incorporates acceleration and braking control in the steering column. The device works something like this: The driver accelerates by pulling the steering wheel toward him and decelerates and applies the brakes by pushing the steering wheel away.

The inventor announces that in tests, the device operates smoothly, presenting no difficulty in maintaining a given road speed, and has been driven safely through city traffic by persons who have never driven before, with only 30 minutes instruction. The estimated installation cost will not be more than $100, but could be built into new cars at the factory without additional cost, according to the maker.

Keeping 34⅓ Million Eggs Fresh with FRICK Refrigeration

That's standard practice at the Indianapolis plant of the Mid-State Frozen Egg Corp., world's largest producers of powdered eggs. Here 14.4 million shell eggs are stored at 35 deg. F.; 1.5 million broken eggs are held at 32 deg.; nearly .5 million are quick-frozen; and 18 million in powdered form are kept at 50—all at one time.

Frick refrigerating, ice-making, and air conditioning equipment plays a vital part in thousands of plants throughout the Food Industries. Also in YOUR plant? If not, let the nearest Frick Branch or Distributor help solve your cooling problems.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO PENNA. U.S.A.

No! Not tan!

You've sworn off tan for life . . . any shade reminiscent of suntan or OD. But it isn't just the color you're tired of. We can prove it when you try on our tans and browns. It's like the difference between what's put in your mess kit, and what Mom cooks up in her kitchen!

THE SPORT SHOP
209 E. State St.

A VITAL PART OF YOUR TELEVISION SET WILL BE A VACUUM
...LITERALLY NOTHING!

THAT'S RIGHT...NOTHING. A blank, an absence of anything ...or, technically, a high vacuum... is all-important to television.

For a high vacuum in a television tube is necessary for control of the electrons that make television a reality.

The first step toward a high vacuum is pumping the air out of the tube. But pumping won't remove enough of it.

Here's where a "getter" of barium, one of the less common metals, comes in—and more air goes out of circulation. Inserted inside the television tube, the barium "getter" is *flashed* from the outside by electricity. Instantly it vaporizes and entraps the remaining air.*

Barium "getters" were developed by KEMET LABORATORIES COMPANY, INC., in their research on metals.

Contributions by this and other UCC Units to television and electronics do not stop here. Radio, radar, X-ray, hearing aids and other electronic devices have also benefited by the extensive research of UCC Units in the fields of alloys, carbons, chemicals, gases and plastics.

▼

**Barium has a high affinity for oxygen... and other gases. When the "getter" is flashed in television or radio tubes, molecules of hot metallic vapor combine with... and immobilize... remaining particles of air. The barium, with the "captured" air is deposited as a silvery film inside the tubes.*

Most UCC products... like barium "getters"... are basic raw materials for American industry. Just about every business enterprise, from the small corner garage to the largest steel plant, uses them in one form or another. If you want a description of these products and how they are used, write for the booklet P-2, "Products and Processes of UCC."

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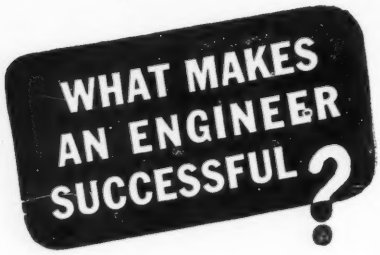

● How does an engineering student eventually become vice president or head of a company? What—over and above his technical education—must he know to qualify as a top executive?

The answer is: a basic understanding of practical business principles and methods.

It is this PLUS knowledge that enables him to see beyond the specialized activities of one department—to grasp the importance of Marketing, Finance and Accounting as well as Production.

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There is a scientific quality about the Institute's Course and Service that appeals to technically-trained men. That is why there are so many prominent members of the engineering profession among the more than 400,000 subscribers. They include: J. W. Assel, Chief Engineer, Timken Steel & Tube Co.; Lewis Bates, Plant Mgr., E. I. du Pont de Nemours & Co.; Lewis P. Kalb, Vice President, Chg. Eng. & Mfg., Continental Motors Corporation; H. W. Steinkraus, President, Bridgeport Brass Co.

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Among the prominent men who have contributed to the Course and Service are: Thomas J. Watson, President, International Business Machines Corp.; Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.; Clifton Slusser, Vice President, Goodyear Tire & Rubber Co.

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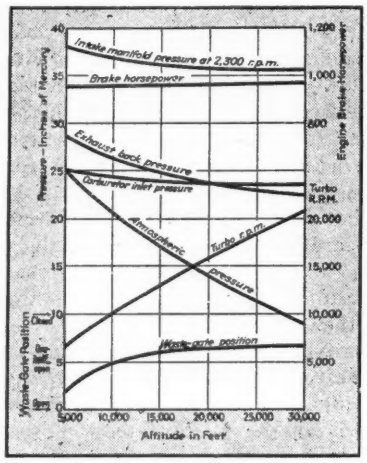
Turbosuperchargers

(*Continued from page* 11)

cause of this location only the pressure of the air delivered to the carburetor can affect the amount of turbosupercharging. Hence, the amount of boost is independent of the outside atmosphere. Electronic amplifiers are used to increase the control current which operate the waste gate motors. Also in the control circuit is the Turbo overspeed governor which prevents excessive rpm. This type of electronic control is extremely sensitive and a more efficient substitute for the slower human reaction and subsequent manual operation.



—*Courtesy Minneapolis-Honeywell*

Fig. 4. Curves showing performance of turbo control equipment during a climb from 5000 to 30,000 feet.

Figure 4 shows the performance of the power plant with electronic turbo control equipment during a climb from 5,000 to 30,000 feet, the engine operating at constant rpm.

Vitallium Alloy

The successful development of the Turbosupercharger was in a large part based on the development of high temperature, corrosion-resistant alloys within the past fifteen years. The metal used in both the turbine wheel and the buckets must withstand the extremely high stresses induced by rotative speeds of 22,000 rpm. and bucket terminal velocities of approximately 1500 feet per second. During operation the buckets are cherry red, since exhaust gas temperatures average 1500° Fahrenheit. This bucket alloy called Vitallium, a cobalt, molybdenum chrome alloy is also non-corrosive at high temperatures. Before the adoption of Vitallium as bucket material, this alloy was used in the manufacture of dental bridgework and medical hardware. It was originally developed for the medical profession since it was impervious to the corrosive action of body fluids.

Precision Bearings

The adaptation of mass production methods to the manufacture of the Turbosupercharger was indeed a real challenge successfully met by engineers both at the General Electric Company and at subcontractor's plants. Besides high temperature alloys, precision ball and roller bearings were developed which could operate at extreme temperatures and rotative speeds in the neighborhood of 25,000 rpm. The design of the bearings included consideration of the natural growth of metals at high temperature and the temperature differentials which might exist between the inner and outer races. In a faulty design, the inner race, since it runs hotter, could expand enough to decrease ball or roller clearance and thus cause the bearing to fail. Tolerances had to be large enough to prevent freezing of the bearing and close enough to prohibit vibration at high rpm. In the design of the separators for the balls and rollers, their capacity to dissipate heat to the lubricating oil had to be considered very carefully.

Originally the buckets were machined from forgings so that they could be dovetailed into the turbine wheel. For small quantity production, this method proved adequate. But when the Turbosupercharger was committed to mass production because of increased military demand, a method was found to cast the buckets in precision molds and then weld them to the turbine wheel. Welding technique and temperature control had to be perfected so that under sustained operating conditions, there would be no warping of buckets and a subsequent decrease in efficiency.

Testing

After final assembly, all Turbo-

(*Continued on page* 34)

You just THINK you're touching aluminum, mister!

Pick it up . . . in your bare hands . . . anything made of aluminum. Your cigarette box. A saucepan. The foil on a chocolate bar.

You're not touching aluminum. You *never* have, never will.

The reason is very simple. Aluminum is constantly covered with the thinnest of thin "skins". It is Aluminum Oxide. You can scrape it off, but it re-forms immediately. In a split second.

This—the scientists at Alcoa's Aluminum Research Laboratories learned many years ago . . . but they didn't stop there. They wanted to know what could be done to this "skin" . . . how it could be made thicker, thinner, harder, porous . . . so that Aluminum products could be more useful and serviceable.

Out of this Alcoa research on the "skin" of aluminum have come many new things. Aluminum pistons of porous "skin", to hold oil. Aluminum trays of lush lustre that won't tarnish—ever. *Colored* aluminum—the color dyed right into the "skin".

Yes, Alcoa has found many ways of not only controlling this "skin" but also of making aluminum better and more versatile in many, many ways . . . *but the search still goes on* and always will.

This *search* calls to young men of science and engineering . . . and spells new opportunity to salesminded men of tomorrow.

The next time you pick up . . . in your bare hands . . . anything made of aluminum, say to yourself, "What *new* could I make this light, strong, durable metal do for man . . . some day?"

ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

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Radio Receivers
Superchargers
Tachometers
Tach Generators
Trim Tabs
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INDUSTRY USES··· millions of feet of S.S.WHITE FLEXIBLE SHAFTS

Yes, S.S.White flexible shafts are among the most useful of basic mechanical elements. The partial list at the left will give you a good idea of the many different products in which they play a part.

And here is the reason for this extensive use —S.S.White flexible shafts provide engineers with a simple, practical answer to two problems which come up again and again in the design of mechanical products—

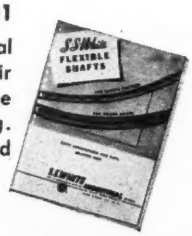
(1) The problem of transmitting rotational power around turns and in paths other than straight lines.

(2) The problem of mechanical remote control.

S.S.White flexible shafts, in both the power drive and remote control types, come in a large selection of diameters and characteristics to meet a wide range of requirements. Engineers will find it helpful to be familiar with the range and scope of these "Metal Muscles" for mechanical bodies.

WRITE FOR BULLETIN 4501

It gives basic facts and technical data about flexible shafts and their application. A free copy will be mailed to you for the asking. Please mention your college and course when you write.



S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT.C, 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

Turbosuperchargers

(*Continued from page* 32)

superchargers are steam tested at twenty-five per cent overspeed. To prove design changes, a Turbosupercharger may undergo a hot gas endurance test which lasts fifty hours or more, in order to determine the effect of an accelerated life. After such a test, it is completely disassembled and each part is very closely examined. To get performance data under simulated flight conditions, the test is often run in an enclosed chamber where the high altitude conditions of temperature and pressure can be imposed.

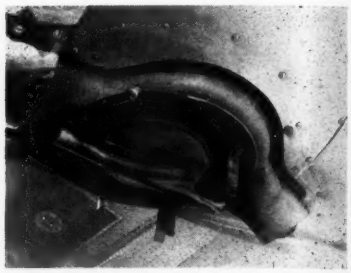
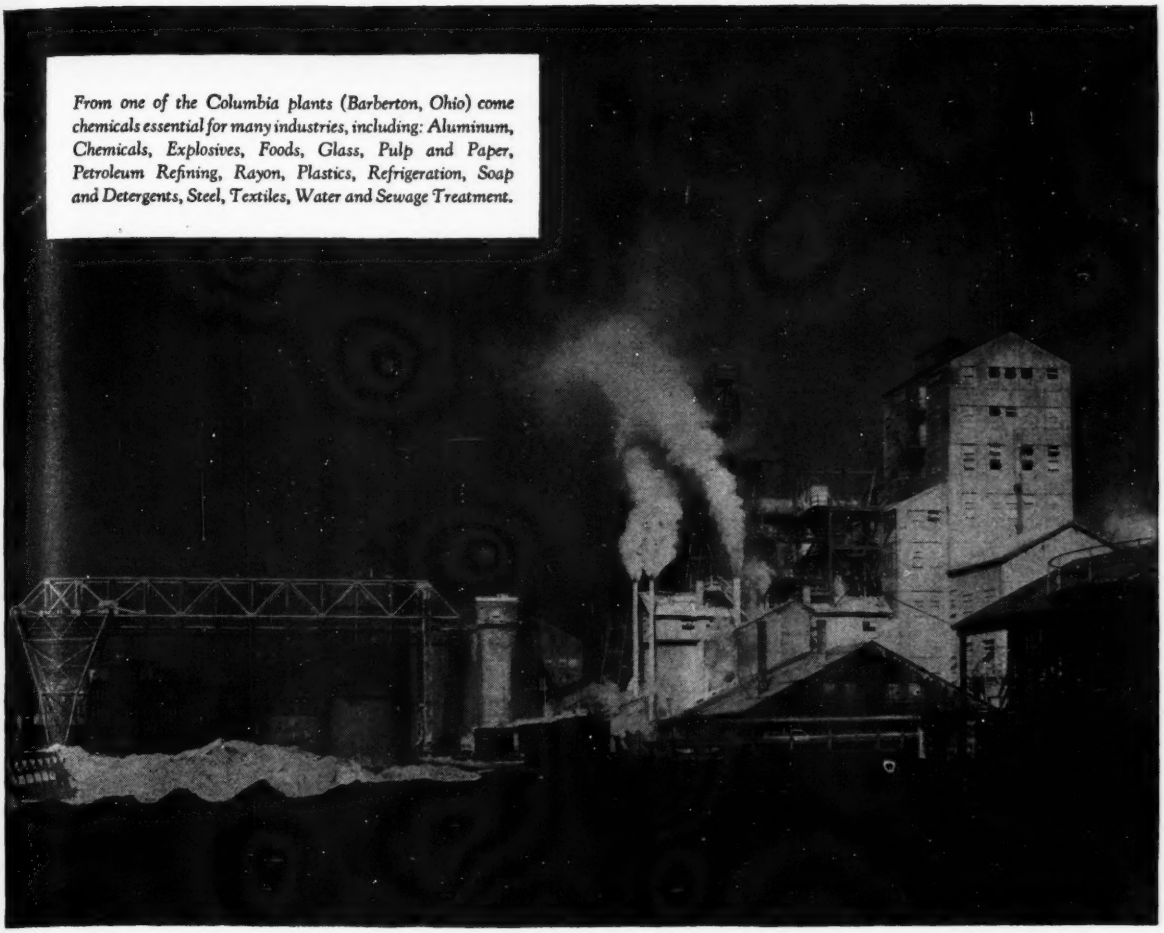


Fig. 5. Turbosupercharger installed underneath the engine nacelle of a B-17. Note a portion of the butterfly valve prortuding from the wastegate.

The manufacturing "know how" learned at the parent plant in Lynn, Massachusetts, was used to set up additional facilities during World War II when the demand for high altitude bombers and fighters was so critical. Plants were established in Everett, Massachusetts and Fort Wayne, Indiana. The techniques perfected in the development and production of the Turbosupercharger formed the basis for the successful design of the turbo jet engines now powering Lockheed's "Shooting Star."

Also fostered by Turbosupercharger research is the aircraft gas turbine which engineers admit may be made to develop 10,000 hp. in the near future. Some engineers predict revolutionary changes in power generation within the next 20 years based on the present tempo of gas turbine research. Although it will not be considered completely responsible the Turbosupercharger will always stand out as the first most successful application of the gas turbine principle.



From one of the Columbia plants (Barberton, Ohio) come chemicals essential for many industries, including: Aluminum, Chemicals, Explosives, Foods, Glass, Pulp and Paper, Petroleum Refining, Rayon, Plastics, Refrigeration, Soap and Detergents, Steel, Textiles, Water and Sewage Treatment.

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Columbia furnishes alkalies and related chemical products to basic industries . . . chemicals that are essential in processes which supply countless needs of modern living.

SODA ASH	CAUSTIC ASH
CAUSTIC SODA	PHOSFLAKE (*bottle washer*)
LIQUID CHLORINE	SODA BRIQUETTES (*iron desulphurizer*)
CALCIUM CHLORIDE	CALCENE T (*precipitated calcium carbonate*)
SODIUM BICARBONATE	SILENE EF (*hydrated calcium silicate*)
MODIFIED SODAS	PITTCHLOR (*calcium hypochlorite*)

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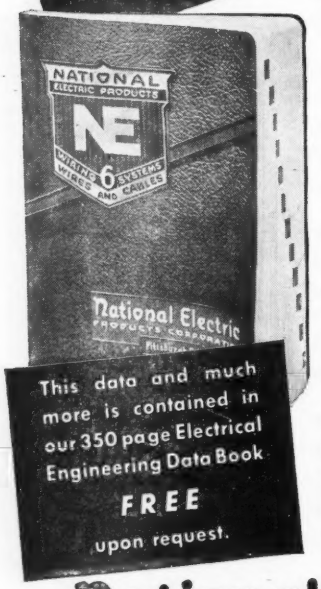
answers to questions on:



- Housing wires and cables in walls and floors.
- Surface housing of wires on ceilings, walls and floors with greatest efficiency and neatness.
- How to eliminate enclosed branch circuits with limited outlets in homes and provide maximum access for fixtures.
- Wires and cables to suit every industrial, commercial and domestic power requirement.

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THE CORNELL CO-OP
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Electric Propulsion

(*Continued from page 9*)

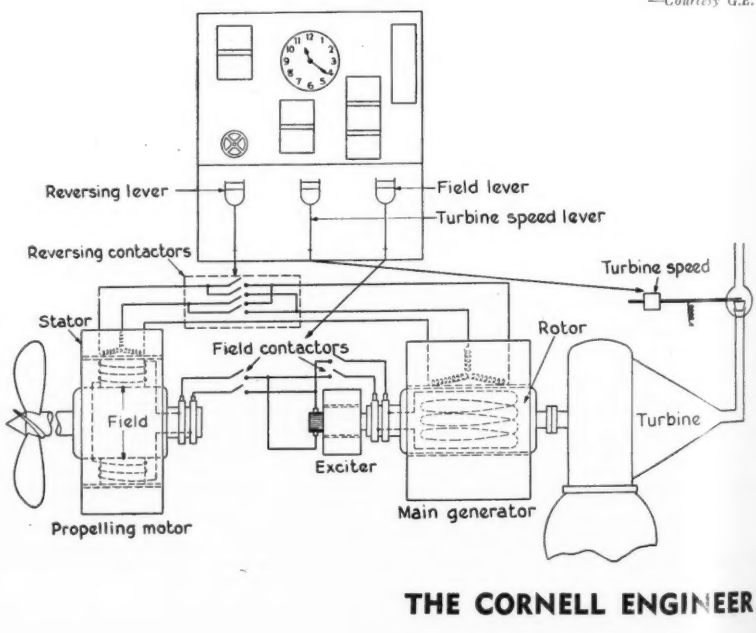
for the special conditions of maneuvering. In maneuvering the ship, the turbine speed and hence the frequency is reduced to between 25 per cent and 30 per cent. The motor without d.c. field excitation is then connected to the generator and brought up to its maximum speed as an induction machine. The motor field is then energized and it pulls into step as a synchronous motor, continuing to operate as such while the ship is accelerated by bringing up the turbine speed and, thus, the frequency. The full turbine speed of many installations is 5600 rpm. with a corresponding motor speed of 400 rpm. During induction motor operation, high excitation of approximately 200 per cent normal is applied to the generator. The resultant high generator voltage at the low frequency (approximately 14 cycles per second) impressed on the induction motor causes a very large current to the motor, and thereby produces adequate motor torque to insure an increase in motor speed to the point where the motor will pull into step as a synchronous machine when the field is energized. The motor torque curve (No. 4) of Figure 1 is for the motor during the maneuvering operation in obtaining a reversal of the ship.

A typical propulsion control board, such as is used on tankers, is shown in Figure 3.

The operating levers consist of a Turbine Speed Lever, Reversing Lever and Field Lever. Figure 4 shows the function of each of these levers in controlling the equipment.

(*Continued on page 38*)

Fig. 4. A schematic diagram of turbine-electric drive control functions. —*Courtesy G.E.*



Start of a big whittling job

LOOK at this great, great grandpappy of the modern transport plane.

Most of it was virtually whittled out of wood.

Now, picture in its place a giant airliner of today with its huge wings, its growling engines, and its magnificent equipment. It, too, is a "whittling" job . . . by fabulous men.

Men who have no limits to their dreams. Men who have incredible skill with tools. Men who perform miracles with metals.

And it is a "whittling" job by *the hardest metal made by man* — an amazing new metal for cutting and forming other metals. Its name is Carboloy Cemented Carbide.

What gives our planes the endurance to fly thousands of *safe* miles in all weather in all climates? What helped to bring back warplanes with tail surfaces half shot away . . . with wings and engines mutilated by steel slugs?

The answer is *super-tough metal alloys.*

Engine parts, wing spars, armor plate and hundreds of other vital airplane parts literally have to be whittled out of these tough, hard alloys. This could never be done quickly and economically unless a harder metal like Carboloy were used for the cutting tools and forming dies.

In fact, high American Air Forces officers have said,

"We couldn't have produced our present aircraft engines on a production basis without carbide tools."

The reasons why Carboloy Cemented Carbide is used throughout the aviation industry and in hundreds of others are simply these:

1. **Its amazing ability to cut and form the toughest alloys at speeds that commonly triple the output of both men and machines.**

2. **Its unbelievable resistance to wear.**

In the air age to come, Carboloy will help bring many new benefits to everyone . . . consumers and manufacturers alike.

Its usefulness will multiply over and over again, not only in tools and dies in every phase of metal working, but also in wear-resistant parts in hundreds of products from automobiles to knife-sharpeners.

A challenge to industry!

It's 10 to 1 that our research men and field engineers can find applications for Carboloy in your plant that will help you improve quality and cut production costs. Why not accept this challenge?

Carboloy Company, Inc., Detroit 32, Mich.

CARBOLOY
(TRADE MARK) • CEMENTED CARBIDE

The Hardest Metal Made by Man

Electric Propulsion

(*Continued from page* 36)

Suppose that the turbine is idling at about 25 per cent speed. The reversing lever is then moved to "ahead" or "astern," as desired. Next, the field lever is moved to position No. 1, which closes field contactors to the generator. When the motor has arrived at a steady speed as indicated on the speed indicator, the field lever is moved to position No. 2. This closes field contactors to motor and brings motor into synchronous operation. The speed can then be adjusted to any desired value by moving the turbine speed lever toward the full speed point. This controls the steam flow to the turbine. To stop the ship, lower the turbine speed to maneuvering position (idling) and push field lever to "off" position. The levers are usually interlocked to prevent faulty operation, such as moving the reversing lever with power on, or starting motor with turbine at full speed.

D.C. Electric Drive

Economy and usefulness is increased considerably when d.c. electric drive is used in some special-use small ships, such as tugs, ferry boats, tenders, mine layers, and mine sweepers. The great advantage of d.c. propeller drive is the adjustable speed ratio between engine and shaft. At reduced speeds or in towing at full horsepower, the d.c. electric drive permits the best and most economical engine speed at the required propeller speed and the necessary more-than-normal torque for full horsepower at reduced speeds. In general, if any large part of the operating time is to be spent in towing at very slow speed, or in much maneuvering, the d.c. electric drive is desirable. The great advantage of the d.c. diesel electric drive, as contrasted wtih diesel-geared, or a.c. diesel electric drive, is the flexibility of the gear ratio where the engine can be run at optimum speed, regardless of the speed of the ship, its load, or perhaps a load due to towing. Currents of 3000 amperes at 250 volts are considered a reasonable limit for commutators and cable assembles, giving about 1000 h.p. per motor. Generally, if large horsepower per shaft is needed, two motors are used on one shaft. Modern 1000 h.p. diesel engines run at about 750 rpm. and are directly connected to the generators. Control is obtained by varying the generated voltage by means of a generator field rheostat, usually controlled from the pilot house, and also a second rheostat located in the engine room, with suitable switching for transferring from one station to the other. Change of direction of propeller rotation is accomplished by reversing the current through the generator fields. Also, speed can be increased by increasing engine speed.

Although the increased use of electric ship propulsion in recent years is in some measure due to the limited facilities available for the production of precision gear reduction units, a large part of the increase is because of the merits inherent in the drive itself. The flexibility possible with the drive has made it extremely valuable as a means of ship propulsion. The Diesel electric drive is an outstanding example of this flexibility.

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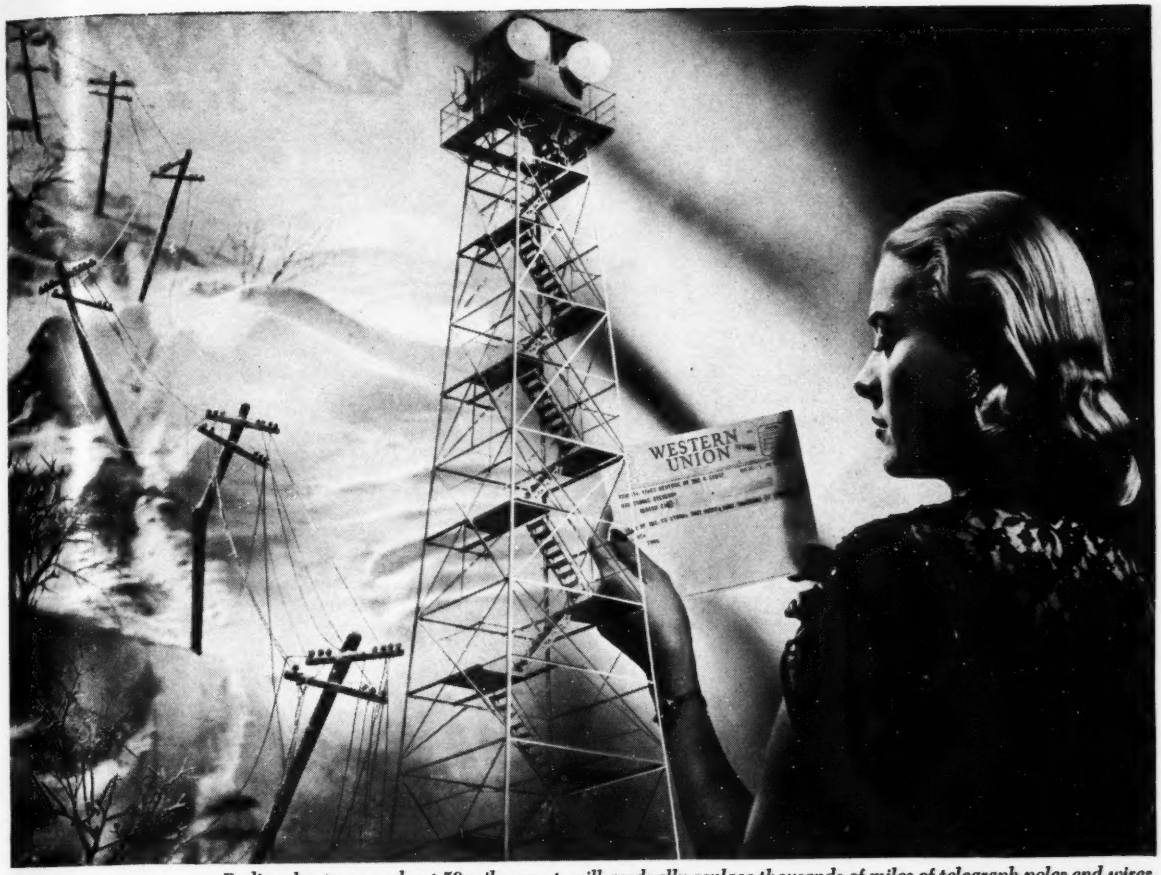


Radio relay towers, about 50 miles apart, will gradually replace thousands of miles of telegraph poles and wires.

Now, telegrams "leapfrog" storms through RCA Radio Relay

With the radio relay system, developed by RCA, Western Union will be able to send telegraph messages between principal cities without poles and wires.

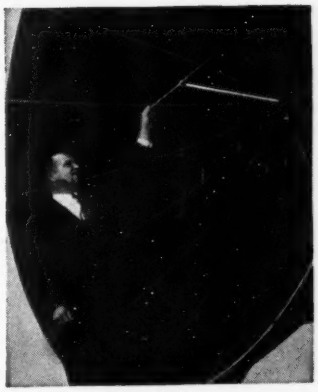
"Wires down due to storm" will no longer disrupt communications. For this new system can transmit telegrams and radiophotos by invisible electric microwaves. These beams span distances up to fifty miles between towers and are completely unaffected by even the angriest storms.

When large numbers of communications circuits are required, these automatic radio relay systems are more efficient than the pole and wire system . . . are less costly to build and maintain. They'll be particularly useful, too, in areas such as China and South America where distances are great and long-line services have not been developed.

This revolutionary stride in communications was made possible by research in RCA Laboratories—the same "make it better" research that goes into *all* RCA products.

And when you buy an RCA Victor radio or television set or a Victrola* radiophonograph, you enjoy a unique pride of ownership. For you know, if it's an RCA it is one of the finest instruments of its kind that science has achieved.

Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y. . . . Listen to The RCA Victor Show, Sundays, 4:30 P. M., Eastern Time, over the NBC Network.



Research in microwaves and electron tubes at RCA Laboratories led to the development by the RCA Victor Division of this automatic radio relay system. Here is a close-up view of a microwave reflector. This system holds great promise of linking television stations into networks, as well as relaying other forms of electric communications.

RCA **RADIO CORPORATION of AMERICA**

*Victrola, T. M. Reg. U. S. Pat. Off.

STRESS and STRAIN...

There is a story going around about a frosh who came to Ithaca without previously reserving a room. After spending a day going from house to house unable to get a place to live, he decided to try downtown. Getting lost, he soon found himself walking along Lake Cayuga. Hearing a cry for help, he saw a man drowning out in the lake.

Rushing over to the bank, our friend shouted: "Before I can help you, I must know your name and address." The poor fellow yelled back: "I'm Fuller Watters and I l've at 000 College Avenue."

The frosh grabbed a bus, rushed over to the address and said to the landlady: "I just came from the lake and I saw the man drown who has a room here."

"Sorry, sir," the landlady replied, "but the room has just been taken by the man who pushed him in."

* * *

After absorbing a good share of the bar's refreshments, a man stumbled out to return to his hotel room. Weaving towards the elevator, he stepped into the open shaft and plummeted down three stories. He arise painfully, brushed off his clothes and look up at the open elevator door.

"You bum," he screamed indignantly, "I said UP."

* * *

The difference between amnesia and magnesia is that the fellow with amnesia doesn't know where he is going.

* * *

A professor at U. of P. noticed a student with his ear close to the wall, listening intently. The student held up a finger as a warning for him to be quiet; then he beckoned him over and said: "Listen here."

The professor put his ear to the wall and listened for some time. Then he turned to the student and said: "I can't hear anything."

"No," said the student, "and it's been like that all day."

The drunk sitting at his favorite bar was startled when a horse entered the establishment and in clear, understandable English ordered two Martinis with two olives in each.

After the bartender had mixed them up, flipped two olives in each cocktail glass and poured them out, the horse swallowed his drinks in quick succession, paid his bill, said "Good afternoon, gentlemen," and walked out.

"Say," said the drunk, "isn't that a bit unusual?"

"No," replied the bartender, "I frequently put two olives in a Martini."

* * *

"It's so simple," explained one of the 406 lab students, "to hook up an electric power circuit. I merely fasten leads to the terminals and pull the switch. If the motor runs, we take our readings. If it smokes, we sneak it back and get another one."

* * *

First Engineer: "Woman's greatest attraction is her hair."

Second Engineer: "I say it's her eyes."

Third Ditto: "I strongly disagree. It's her teeth."

A Sibley Senior: "What's the use of our sitting here and lying to each other like that?"

* * *

Prof. Perkins: "Are you smoking back there?"

Mech. Student: "No sir, that's just the fog I'm in."

* * *

Two workmen sat down to eat their lunch and one began unwrapping a parcel about 18 or 20 inches long.

"What's that?" asked his friend.

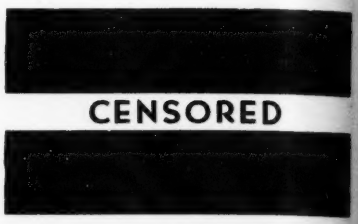
"Well, my wife is away, so I made a pie for myself."

"A bit long, ain't it?"

"Of course it's long. It's rhubarb."

Student to landlady: "Don't you think the window of this room is rather small in case of an emergency?"

Landlady: "There won't be an emergency—my terms are cash in advance."



Visitor: "Does Mr. Coleman, a student, live here?"

Landlady: "Well, a Mr. Coleman lives here, but I thought he was a night watchman."

* * *

Papa loved mama,
Mama loved men;
Mama's in the graveyard,
Papa's in the pen.

* * *

Prof.: "I won't begin today's lecture until the room settles down."

Voice from Rear: "Go home and sleep it off, old man."

* * *

"I can't marry that man, mother," said the sad girl. "He is an atheist and does not believe there is a hell."

"Marry him," said the prospective mother-in-law, "and between the two of us we'll convince him that he's wrong."

* * *

Father (looking cautiously into the living room of a fraternity house): "Does Johnny Jones live here?"

Voice from Inside: "Yeah, just lay him on the couch."

* * *

The naked hills lie wanton to the breeze,
The fields are nude, the groves unfrocked,
Bare are the shivering limbs of shameless trees,
What wonder is it that the corn is shocked?